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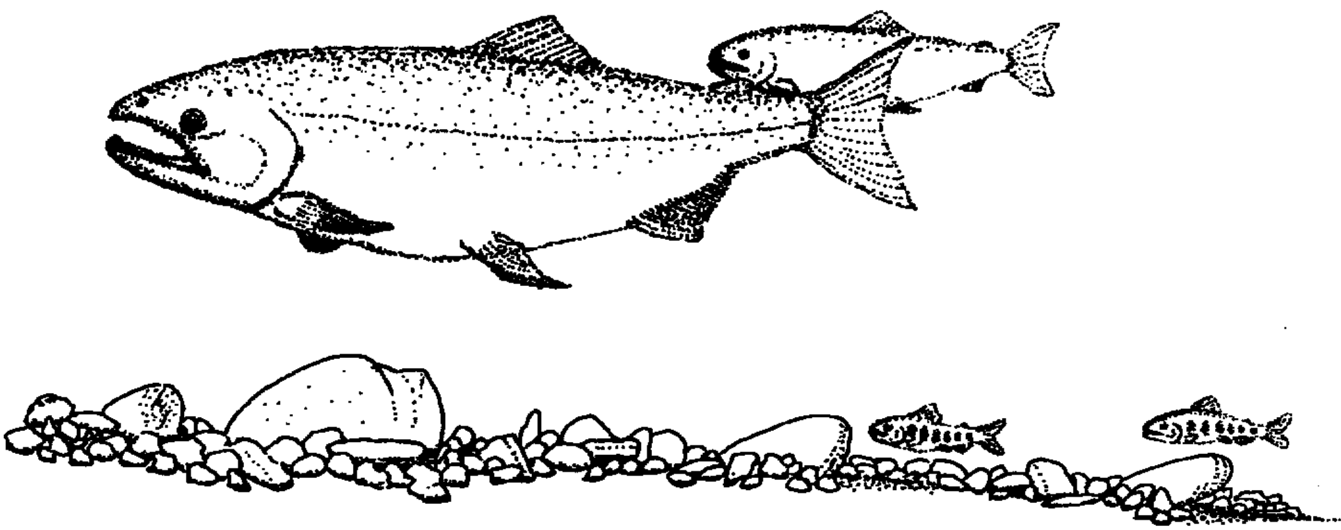

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A Test Of Remote Site Incubators Using Green, Untreated Fall Chinook Salmon Eggs

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ABSTRACT

The remote site incubator (RSI), a new tool for increasing egg-to-fry survival, appeared to have potential for application in very remote locations. Our objective was to identify a low maintenance system that would increase egg-to-fry survival rates compared to variable and often poor natural spawning rates. Developed by Washington Department of Fisheries (WDF) during 1985-86, single, 55-gal barrel RSIs had been used to successfully incubate over 100,000 eyed, treated salmon eggs with occasional operator maintenance. We tested RSIs for incubation success using green, untreated fall chinook eggs with minimal operator maintenance. The proposed test would represent conditions and requirements for use of RSI in a very remote location where a depressed wild chinook salmon *Oncorhynchus tswaytscha* run returns to spawn and increased egg-to-fry survival is desired.

The test was performed at four locations, two using spring flow and two using small creek flow, on the west shore of Hood Canal, Washington. The test was also designed to compare effects of varying egg densities in egg trays and relative vertical order of trays with varying egg densities. A total of eight RSIs contained either 10,000 or 18,000 eggs, with tray egg density varying from 1,000 to 5,000 eggs. To simulate the restrictions of use at a completely remote location, green, untreated fall chinook eggs obtained from the Hood Canal Hatchery were used for the test. Operator visits were restricted to initial loading of RSI, a return to count but not remove dead eggs, and a return to count dead and dying fry after fry emigration.

All eight RSIs functioned normally during the test. Total egg and fry loss varied from 3.4% to 8.7%. Mean percent survival among four RSI using spring flow was 95.2, and among four RSI using creek flow was 96.4. We concluded that RSI, given a dependable, clean water source could meet our objective of increasing egg-to-fry survival with little or no maintenance in very remote locations.

INTRODUCTION

One of the principal mandates of the Western Washington Fishery Resource Office (WWFRO), U. S. Fish and Wildlife Service, Olympia, Washington, is restoration of depressed wild runs of salmon and steelhead in western Washington. Some depressed wild runs return to upper watershed areas that are not accessible by road or boat. We previously participated in a study of a depressed spring chinook run in a remote area of Olympic National Park, to determine how to capture adults just prior to spawning and to remove gametes to a hatchery where successful incubation could occur (Wampler 1991). While the study was a partial success, incubation in the hatchery failed. The long distances probably resulted in poor handling of eggs and gametes; we sought a method with a better hatching rate.

A new tool and procedure appeared to have potential for increasing wild egg-to-fry survival at their stream of origin. The remote site incubator (RSI) was developed by Mr. Jerry Manuel, an employee of Washington Department of Fisheries (WDF), during 1985-86 (J. Manuel et al. 1991). Fish survival in RSIs, from incubation to fry emigration, was high. It was routine for RSIs containing over 100,000 eyed, fungicide-treated eggs to support survival to the fry stage in excess of 90%.

Physical site requirements for operating a successful RSI are adequate flow of clean water, sufficient hydraulic head to provide upwelled flow through the RSI, and location above the stream's floodway. A continuous flow of at least 10 gallons per minute through a 55-gal barrel incubator is required (J. Manuel et al. 1991). The water source must be of high quality. Typically, a spring flow is used, but flow in clear-running, small streams is also satisfactory. In marginal or intermittent quality streams, a water clarifier is added to the inflow line to remove sediment. Hydraulic head must be 40 to 48 in. Location of the RSI and associated plumbing must be above any effect from stream flooding throughout the incubation and fry development period.

Following installation, RSI were normally loaded with eggs equally divided into a series of stacked, round screens, positioned over a gravel/artificial substrate (Figure 1). After eggs hatch, alevins drop to temporarily reside in the substrate, button up, and then ascend to exit the RSI via the outlet near the barrel top. At least two additional operator visits to RSI were required, the first to remove screens and dead eggs after the hatch, and the second to either shut down or dismantle the RSI.

Prior to this study, RSI had not been used with green, untreated eggs, and only on few occasions had chinook eggs been used. Based on WDF results using RSIs, we concluded that RSIs might advance our objective if survival was high when RSIs were loaded with green, untreated eggs.

An initial, unscheduled test during spring, 1991, was quickly arranged at the Quinault National Fish Hatchery, near Neilton, Washington. In that test we used green, untreated winter steelhead *O. mykiss* eggs loaded into modified screen trays and supplied with surface water flow diverted from a hatchery water source. A half-inch grid had been attached to the screen tray so that eggs would be somewhat separated to prevent fungus spread. We observed about 50% hatching success and concluded that further testing of RSI using chinook eggs in modified screens, was needed.

We then designed a study beginning in the fall, 1991 to test for survival among green, untreated fall chinook eggs loaded in plastic screen trays, redesigned to minimize fungus spread. The study would also compare survival from two egg-loading strategies, and two types of water source, spring flow and small creek flow.

METHODS

We selected four RSI sites, previously established by WDF adjacent to Hood Canal, for our study locations (Figure 2). The sites near John Creek and Lilliwaup Creek used spring flow while the sites on Fulton and Eagle Creeks used diverted creek flow. Two 55-gal RSIs were used at each site. From sand bag impoundments, six-inch diameter PVC pipe with screened intake conveyed flow down varying distances to side-by-side RSIs. Immediately up-flow and a few inches from each barrel, a standpipe was positioned for use in controlling water level in the barrel. Inside each barrel, two-inch PVC pipe conveyed flow into a water diffuser assembly, from which flow upwelled first through a layer of pea gravel, then a layer of bio saddles (two-inch irregularly shaped polypropylene pieces), then a series of egg trays also containing bio saddles (single layer), and finally exiting from a PVC outlet pipe located near the barrel top (Figure 1). Egg trays were constructed with 1/4-inch mesh vexar screen set in polypropylene hoops. A lid on each RSI protected eggs from light, predators and introduction of foreign matter.

Green fall chinook eggs and milt were transferred from the WDF Hood Canal Hatchery, Hoodsport, WA, in separated, chilled, air-filled bags to Lilliwaup Creek, Eagle Creek, Fulton Creek, and John Creek on September 30, October 2, 3, and 8, 1991, respectively.

We identified one RSI at each site as barrel 1 and the other RSI as barrel 2. In barrel 1 at each site, egg loading density was increased from top tray to bottom while egg density was decreased from top tray to bottom in barrel 2 (Table 1). Empty spacers were placed between trays in RSI at Lilliwaup Creek (spring flow) and at Fulton Creek (creek flow). We added spacers to these RSI to see if additional vertical distance between trays would reduce egg loss.

Maximum egg loading in any tray was 5000 eggs and minimum egg loading was 1000 eggs (Table 1). The method for counting eggs was determined earlier by actual egg count in a standard cup used for egg transfer. Our intent in increasing egg loading from top to bottom or bottom to top was to see if increased egg density down-flow, i.e., higher in the upwelling water flow, reduced total egg loss.

Following arrival at each site, eggs were fertilized and carefully spread into trays according to the assigned loading density. Immediately afterward, we adjusted flow through each RSI to the proper rate and assured that the system was functioning correctly.

On December 20, 1991, we briefly opened each RSI and counted, but did not remove, dead eggs in each egg tray. On February 29, 1992, we again briefly opened each RSI and counted dead or dying fry remaining in trays, well after fry had descended into the bio saddles.

RESULTS

On December 20, our count of dead eggs in RSI varied from 326 to 819 (Table 1). The highest and lowest egg loss per tray in any RSI was 11.5% in barrel 1 at Lilliwaup Creek and 0.6% in barrel 2 at John Creek (Table 1). Mean percent egg loss per tray in RSIs varied from 1.9 in barrel 2 at John Creek to 8.2 in barrel 1 at Lilliwaup Creek.

The use of spacers in RSI appeared to have no positive effect on percent egg survival. In fact, mean percent loss among trays in RSIs without spacers, at John and Eagle Creeks, were all lower than respective means in RSIs with spacers (Table 1).

Comparison of egg loss in RSIs containing upwardly increased egg loading density with egg loss in RSIs containing downwardly increased egg loading density showed no clear trend. We had hypothesized that loading bottom trays with the maximum number of eggs would minimize egg loss due to upward spread of fungus from infection in lower trays. This theory was not clearly demonstrated in any RSI.

We determined that all healthy fry should have migrated from RSI by February 29, based on past observations in RSIs and water temperature at the study sites. On that day, our count of dead and dying fry in RSIs varied from 10 to 86 (Table 2). We carefully searched through the bottom substrate as well as the egg tray substrate to locate all remaining live and dead fry. We did not associate location of dead or dying fry with particular trays because of fry mobility. Live fry were either deformed or in a weakened state due to abnormal development. It was apparent that we were not missing any dead fry due to total decay because remains of many dead eggs were still recognizable in all RSIs.

The sums of total egg loss and total dead or dying fry counted in RSIs indicate the total loss (Table 3). From those values, we determined the percent loss in each RSI, and the corresponding percent survival in each RSI. Percent survival of fry that emigrated from RSIs, compared to the original number of eggs loaded into each RSI, ranged from 91.3% to 97.7%. The mean survival among RSIs using spring flow was 95.2% while that among RSIs using creek flow was 96.4%. The overall mean survival among all RSIs was 95.8%.

DISCUSSION AND CONCLUSIONS

This study was not analyzed statistically because RSI replicates were too few to satisfy statistical criteria (Snedecor and Cochran 1967). However, our basic objective of determining the relative survival from green, untreated fall chinook eggs to emigrating fry in RSIs was met. Only one RSI had survival less than 95%. This very clearly demonstrates the potential for RSI in remote locations using green eggs and an absolute minimum of operator visits. We are confident that future use of the RSI design used in this study would have acceptable results, assuming that high quality water sources are used.

Higher rates of egg loading would be desired in extremely remote sites. Based on our results, we recommend loading at least 5000 eggs into each tray in an RSI. It is likely that some number of additional trays could be accommodated as well, but this should be tested first. Better documentation of the fate of fry emigrating from RSI and their rate of contribution to runs or fisheries is also needed.

Information on details of RSI construction and advice on selecting suitable water sources are available from WDF.

As a word of caution regarding use of RSIs in streams where wild runs exist, recent work documents the importance of avoiding potential negative impacts that arise from inappropriate supplementation programs (Miller et al. 1990).

ACKNOWLEDGEMENTS

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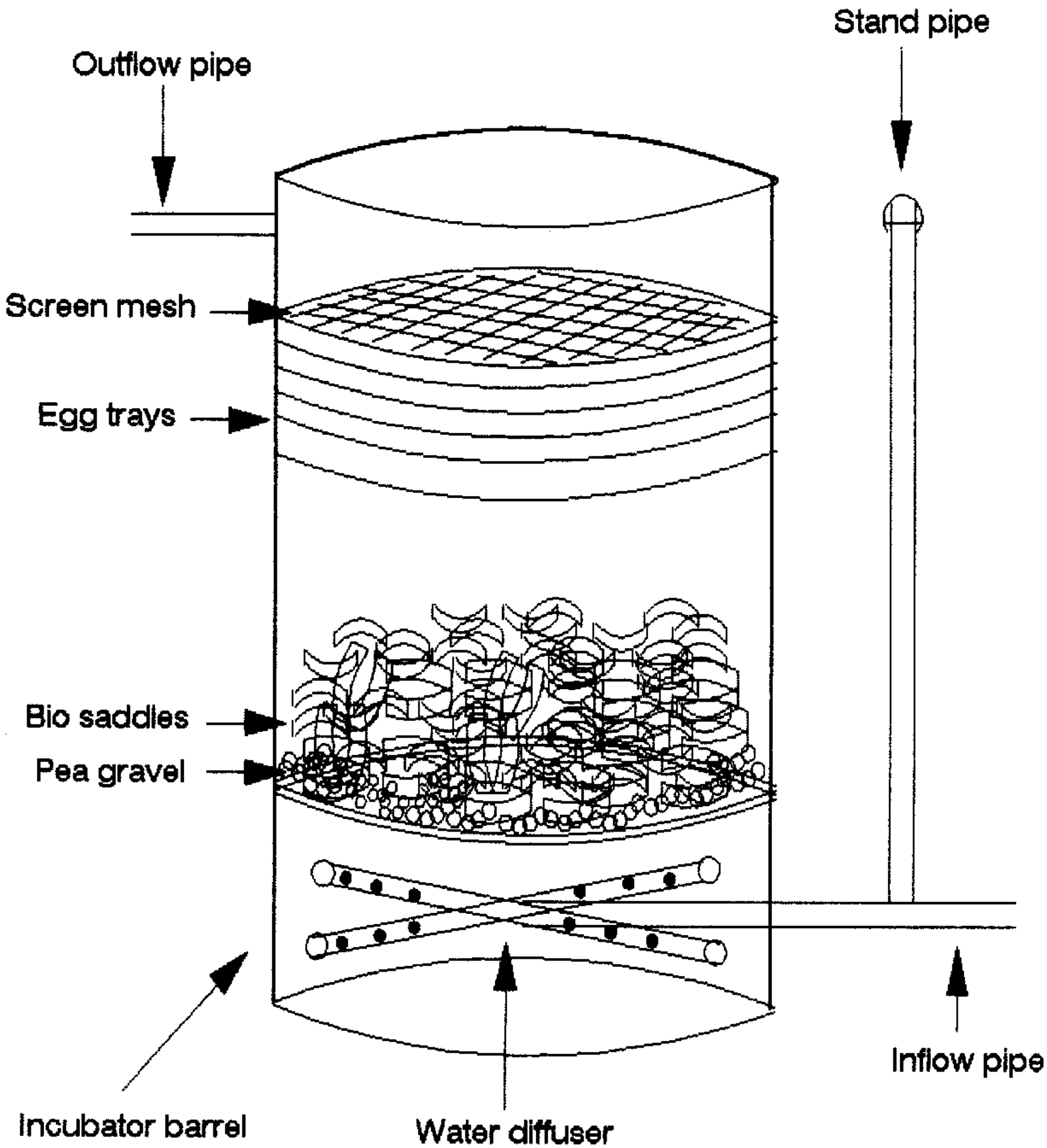

Figure 1. Components of the remote site incubator.

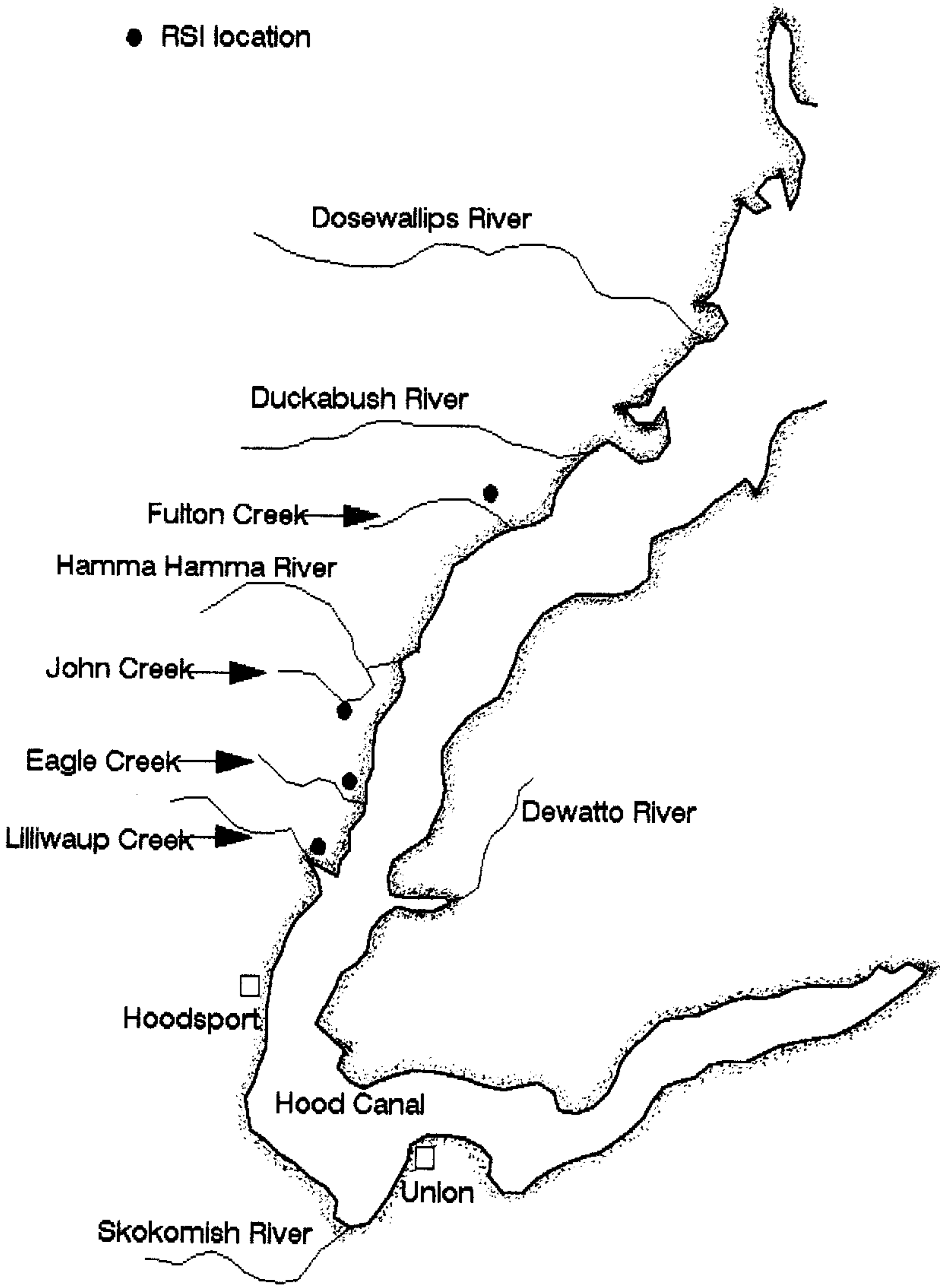

Figure 2. RSI locations at Fulton, John, Eagle, and Lilliwaup Creeks on Hood Canal, Washington.

Table 1. Dead eggs found in the paired RSI barrels on December 20, 1991, compared to original egg loading densities per tray.

Study site	Water source	Egg tray	Barrel 1 Loading density	Barrel 1 Dead eggs	Barrel 1 % loss	Barrel 2 Loading density	Barrel 2 Dead eggs	Barrel 2 % loss
Lilliwaup Creek	Spring flow	1 (Top)	1000	97	9.7	5000	168	3.4
		2	1000	92	9.2	0		
		3	0			3000	129	4.3
		4	3000	346	11.5	0		
		5	0			1000	46	4.6
		6 (Bottom)	5000	284	5.7	1000	63	6.3
	Total dead eggs			**819**	**8.2**		**406**	**4.1**
John Creek	Spring flow	1 (Top)	1000	34	3.4	5000	105	2.1
		2	1000	42	4.2	5000	73	1.5
		3	3000	102	3.4	3000	55	1.8
		4	3000	87	2.9	3000	103	3.4
		5	5000	204	4.1	1000	8	0.8
		6 (Bottom)	5000	183	3.7	1000	6	0.6
	Total dead eggs			**652**	**3.6**		**350**	**1.9**
Eagle Creek	Creek flow	1 (Top)	1000	69	6.9	5000	188	3.8
		2	1000	32	3.2	5000	91	1.8
		3	3000	91	3.0	3000	45	1.5
		4	3000	96	3.2	3000	106	3.5
		5	5000	168	3.4	1000	13	1.3
		6 (Bottom)	5000	189	3.8	1000	15	1.5
	Total dead eggs			**645**	**3.6**		**458**	**2.5**
Fulton Creek	Creek flow	1 (Top)	1000	95	9.5	5000	118	2.4
		2	1000	35	3.5	0		
		3	0			3000	108	3.6
		4	3000	34	1.1	0		
		5	0			1000	86	8.6
		6 (Bottom)	5000	162	3.2	1000	64	6.4
	Total dead eggs			**326**	**3.3**		**376**	**3.8**

Table 2. Dead and dying fry found in RSI following emigration.

Dead and dying fry	Barrel 1	Barrel 2
	Lilliwaup Creek	
In trays	43	18
In bottom substrage	4	19
Total loss	47	37
	Fulton Creek	
In trays	2	13
In bottom substrate	8	7
Total loss	10	20
	John Creek	
In trays	28	24
In bottom substrate	14	45
Total loss	42	69
	Eagle Creek	
In trays	21	24
In bottom substrate	65	34
Total loss	86	58

Table 3. Total fish loss during incubation and alevin stages and percent survival to emigration in RSI.

	Spring Flow				Creek Flow			
	Lilliwaup Creek		John Creek		Fulton Creek		Eagle Creek	
Barrel #	1	2	1	2	1	2	1	2
Initial live eggs	10,000	10,000	18,000	18,000	10,000	10,000	18,000	18,000
Total egg loss	819	406	652	350	326	376	645	458
Total fry loss	47	37	42	69	10	20	86	58
Combined egg and fry loss	866	443	694	419	336	396	731	516
Combined loss as % initial live eggs	8.7	4.4	3.9	2.3	3.4	4.0	4.1	2.9
Survival as % initial live eggs	91.3	95.6	96.1	97.7	96.6	96.0	95.9	97.1